CLAIMS

1. A method of making plurality of features in a first layer, comprising:

forming a photoresist layer over the first layer;

exposing dense regions in the photoresist layer through a first mask under a first set of illumination conditions;

exposing at least one isolated region in the photoresist layer through a second mask different from the first mask under a second set of illumination conditions different from the first set of illumination conditions;

patterning the exposed photoresist layer; and

patterning the first layer using the patterned photoresist layer as a mask.

2. The method of claim 1, wherein the step of patterning the photoresist layer comprises removing the exposed dense and isolated regions in the photoresist layer.

3. The method of claim 1, wherein the step of patterning the photoresist layer comprises removing the unexposed regions in the photoresist layer without removing the exposed dense and isolated regions in the photoresist layer.

4. The method of claim 1, wherein:

the first layer comprises an insulating layer; and

the step of patterning the first layer comprises providing an etching gas or an etching liquid to the first layer through openings in the patterned photoresist layer to form a plurality of dense and isolated openings in the first layer.

5. The method of claim 1, wherein:

the first layer comprises a semiconductor or a conductive layer; and

the step of patterning the first layer comprises providing an etching gas or an etching liquid to the first layer through opening in the patterned photoresist layer to form a plurality of features in the first layer.

6. The method of claim 1, wherein the first set of illumination conditions and the second set of illumination conditions differ by at least one of focus, partial coherence, numerical aperture width, and illumination type.

7. The method of claim 6, wherein the first set of illumination conditions has a different focus than the second set of illumination conditions.

8. The method of claim 6, further comprising:

selecting the first set of illumination conditions that are optimized to expose dense regions in the photoresist layer; and

selecting the second set of illumination conditions that are optimized to expose isolated regions in the photoresist layer.

9. The method of claim 8, wherein the dense exposed regions are separated by 500 nm or less from a nearest other exposed region and the isolated exposed regions are separated by more than 500 nm from a nearest other exposed region.

10. The method of claim 8, wherein the dense exposed regions are separated by 300 nm or less from a nearest other exposed region and the isolated exposed regions are separated by 1 micron or more from a nearest other exposed region.

11. The method of claim 10, further comprising exposing semi-dense regions separated by 301 to 999 nm in the photoresist layer through a third mask different from the first and the second masks under a third set of illumination conditions different from the first and the second sets of illumination conditions.

12. The method of claim 1, wherein values of exposure dose and defocus used to expose the dense regions or the at least one isolated region are located in a respective process window outside an overlap region between the respective process windows.

13. A solid state device made by the process of claim 1.

14. A method of making a semiconductor device, comprising:

forming a first layer of the semiconductor device;

forming a photoresist layer over the first layer;

exposing dense regions in the photoresist layer through a first mask using a first focus;

exposing isolated regions in the photoresist layer through a second mask different from the first mask using a second focus different from the first focus;

removing the exposed dense and isolated regions in the photoresist layer to form a patterned photoresist layer; and

etching the first layer using the patterned photoresist layer as a mask.

15. The method of claim 14, wherein:

the first layer comprises an insulating layer; and

the step of etching the first layer comprises providing an etching gas or an etching liquid to the first layer through openings in the patterned photoresist layer to form a plurality of dense and isolated openings in the first layer.

16. The method of claim 14, wherein:

the first layer comprises a semiconductor or a conductive layer; and

the step of etching the first layer comprises providing an etching gas or an etching liquid to the first layer through openings in the patterned photoresist layer to form a plurality of features in the first layer.

17. The method of claim 14, further comprising:

selecting the first focus which is optimized to expose dense regions in the photoresist layer; and

selecting the second focus which is optimized to expose isolated regions in the photoresist layer.

18. The method of claim 14, wherein the dense exposed regions are separated by 500 nm or less from a nearest other exposed region and the isolated exposed regions are separated by more than 500 nm from a nearest other exposed region.

19. The method of claim 14, wherein the dense exposed regions are separated by 300 nm or less from a nearest other exposed region and the isolated exposed regions are separated by 1 micron or more from a nearest other exposed region.

20. The method of claim 18, further comprising exposing semi-dense regions separated by 301 to 999 nm in the photoresist layer through a third mask different from the first and the second masks using a third focus different from the first and the second focus.

21. The method of claim 14, wherein values of exposure dose and defocus used to expose the dense regions or the isolated regions are located in a respective process window outside an overlap region between the respective process windows.

22. A semiconductor device made by the process of claim 14.

23. A method of making a semiconductor device, comprising:

forming at least one semiconductor device on a substrate;

forming a first insulating layer over the semiconductor device;

forming a photoresist layer over the first insulating layer;

exposing dense regions in the photoresist layer through a first mask using a first focus;

exposing isolated regions in the photoresist layer through a second mask different from the first mask using a second focus different from the first focus;

removing the exposed dense and isolated regions in the photoresist layer to form dense and isolated openings in the photoresist layer;

providing an etching gas or an etching liquid to the first insulating layer through the dense and the isolated openings in the photoresist layer to form a plurality of dense and isolated openings in the first insulating layer; and

forming a conductive material in the dense and the isolated openings.

24. The method of claim 23, further comprising:

selecting the first focus which is optimized to expose dense regions in the photoresist layer; and

selecting the second focus which is optimized to expose isolated regions in the photoresist layer.

25. The method of claim 23, wherein:

the dense exposed regions are separated by 500 nm or less from a nearest other exposed region;

the isolated exposed regions are separated by more than 500 nm from a nearest other exposed region;

the dense openings in the first insulating layer are separated by 500 nm or less from a nearest other opening; and

the isolated openings in the first insulating layer are separated by more than 500 nm from a nearest other opening.

26. The method of claim 23, wherein the dense exposed regions are separated by 300 nm or less from a nearest other exposed region and the isolated exposed regions are separated by 1 micron or more from a nearest other exposed region.

27. The method of claim 26, further comprising exposing semi-dense regions separated by 301 to 999 nm in the photoresist layer through a third mask different from the first and the second masks using a third focus different from the first and the second focus.

28. The method of claim 23, wherein:

the substrate comprises a semiconductor, a glass or a plastic material;

the first insulating layer comprises at least one of silicon oxide, silicon nitride, silicon oxynitride, fluorinated silicon oxide, aluminum oxide, tantalum oxide, BPSG, PSG, BSG or spin on glass;

the conductive material comprises at least one of polysilicon, aluminum, copper, tungsten, titanium, titanium nitride or metal silicide; and

the at least one semiconductor device comprises at least one of a MOSFET, a MESFET, a bipolar transistor, a capacitor or a resistor.

29. The method of claim 23, wherein the step of exposing the dense regions occurs before the step of exposing the isolated regions.

30. The method of claim 23, wherein the step of exposing the dense regions occurs after the step of exposing the isolated regions

31. The method of claim 23, wherein values of exposure dose and defocus used to expose the dense regions or the isolated regions are located in a respective process window outside an overlap region between the respective process windows.

32. A semiconductor device made by the method of claim 23.